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FORM PTO-1390) (REV. 9-2001) U.S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE	ATTORNEY'S DOCKET NUMBER
TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371	**843.41117X00 filed January 25, 2002**
	U.S. APPLICATION NO. (If known, see 37 CFR 1.5) **10/031785**

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/JP00/05012	**July 27, 2000**	**July 27, 1999**

TITLE OF INVENTION
SEMICONDUCTOR CONTAINER OPENING/CLOSING APPARATUS AND SEMICONDUCTOR DEVICE MANUFACTURING METHOD

APPLICANT(S) FOR DO/EO/US
KOBAYASHI, YOSHIAKI KOBAYASHI, SHIGERU TAKUNAGA, KENJI KATO, KOJI MINAMI, TERU

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. ☒ This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.

2. ☐ This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.

3. ☐ This express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.

4. ☐ The US has been elected by the expiration of 19 months from the priority date (Article 31).

5. ☒ A copy of the International Application as filed (35 U.S.C. 371(c)(2)))
   a. ☐ is transmitted hereto (required only if not communicated by the International Bureau).
   b. ☒ has been communicated by the International Bureau.
   c. ☐ is not required, as the application was filed in the United States Receiving Office(RO/US)

6. ☒ An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. ☒ is attached hereto.
   b. ☐ has been previously submitted under 35 U.S.C. 154(d)(4).

7. ☐ Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. ☐ are attached hereto (required only if not communicated by the International Bureau).
   b. ☐ have been communicated by the International Bureau.
   c. ☐ have not been made; however, the time limit for making such amendments has NOT expired.
   d. ☐ have not been made and will not be made.

8. ☐ An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371(c)(3)).

9. ☒ An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).

10. ☐ An English language translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. ☐ An Information Disclosure Statement under 37 CFR 1.97 and 1.98.

12. ☒ An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.

13. ☐ A FIRST preliminary amendment.

14. ☐ A SECOND or SUBSEQUENT preliminary amendment.

15. ☐ A substitute specification.

16. ☒ A change of power of attorney and/or address letter.

17. ☐ A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825.

18. ☐ A second copy of the published international application under 35 U.S.C. 154(d)(4).

19. ☐ A second copy of the English language translation of the international application under 35 U.S.C. 154(d)(4).

20. ☒ Other items or information: **Figs. 1-8, Credit Card Payment Form, PCT Request Form, International Preliminary Examination Report, International Publication No. WO 01/08212, International Search Report with references**

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10/051785	PCT/JP00/05012	843.41117X00

21. The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492(a) (1) - (5)):

☐ Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**

☒ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**

☐ International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**

☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**

☐ International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**

	CALCULATIONS PTO USE ONLY	
ENTER APPROPRIATE BASIC FEE AMOUNT =	**$890.00**	
Surcharge of **$130.00** for furnishing the oath or declaration later than ☐ 20 ☐ 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$	

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	$	
Total Claims	4 - 20 =	0	x **$18.00**	$	
Independent Claims	3 - 3 =	0	x **$84.00**	$	
MULTIPLE DEPENDENT CLAIMS(S) (if applicable)			+ **$280.00**	$	
			TOTAL OF ABOVE CALCULATIONS =	**$890.00**	
☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by ½.			+	$	
			SUBTOTAL =	**$890.00**	
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			TOTAL NATIONAL FEE =	**$890.00**	
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property			+	**$40.00**	
			TOTAL FEES ENCLOSED =	**$930.00**	
			Amount to be refunded:		$
			charged:		$

a. ☐ A check in the amount of $_____ to cover the fees is enclosed.

b. ☐ Please charge my Deposit Account No. **01-2135** in the amount of $_____ to cover the above fees. A duplicate copy of this sheet is enclosed.

c. ☒ The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposition Account No. **01-2135**. A duplicate copy of this sheet is enclosed.

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NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137(a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO:

Antonelli, Terry, Stout & Kraus, LLP
1300 North Seventeenth Street
Suite 1800
Arlington, VA 22209
USA

SIGNATURE

Gregory E. Montone
NAME

28,141
REGISTRATION NO.

FORM PTO-1390) (REV. 9-2001) U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY'S DOCKET NUMBER: **843.41117X00 filed January 25, 2002**

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TITLE OF INVENTION: **SEMICONDUCTOR CONTAINER OPENING/CLOSING APPARATUS AND SEMICONDUCTOR DEVICE MANUFACTURING METHOD**

APPLICANT(S) FOR DO/EO/US: **KOBAYASHI, YOSHIAKI KOBAYASHI, SHIGERU TAKUNAGA, KENJI KATO, KOJI MINAMI, TERU**

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☐ Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by ½.			+	**$**	
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Suite 1800
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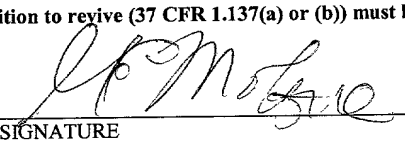
USA



SIGNATURE

Gregory E. Montone

NAME

28,141

REGISTRATION NO.

8/prts

SPECIFICATION

TITLE OF THE INVENTION

SEMICONDUCTOR CONTAINER OPENING/CLOSING APPARATUS

AND

SEMICONDUCTOR DEVICE MANUFACTURING METHOD

TECHNICAL FIELD OF THE INVENTION

The present invention relates to a semiconductor container opening/closing apparatus, which opens and closes a lid of a semiconductor wafer container used in semiconductor manufacturing process, and relates to a semiconductor device manufacturing method in which the semiconductor container opening/closing apparatus is installed in each semiconductor manufacturing apparatus and a semiconductor wafer is conveyed using the semiconductor wafer container.

BACKGROUND OF THE INVENTION

Recently, in a semiconductor manufacturing plant, a semiconductor wafer is conveyed between each manufacturing apparatus while being stored in a semiconductor container (hereinafter, referred to as a container) with a lid that isolates the semiconductor wafer from the outer environment. The inside of the container is kept in a very clean condition in comparison to the outside and only a small number of foreign particles are adhered to the wafer inside the container if the lid of the container is not opened. The condition outside the container is the ISO cleanliness level 6 or the like, and if

the wafer is left in such a condition, the foreign particles are adhered to a surface of the wafer with time. Consequently, the yield of a semiconductor component formed on the wafer is significantly decreased. The container opening/closing apparatus is provided in each manufacturing apparatus, and the inside of the manufacturing apparatus is kept in a very clean condition in comparison to the outside, that is, the ISO cleanliness level 1 to 2.

When the wafer is conveyed from the container to the manufacturing apparatus or from the manufacturing apparatus to the container, the manufacturing apparatus and the container is first connected to each other via the container opening/closing apparatus, and then the lid of the container is opened, and thereby it is possible to directly connect the clean area inside the manufacturing apparatus and the clean area inside the container. Therefore, there is little possibility that the wafer is exposed to the outside air.

The velocity of opening the lid of the container in the conventional container opening/closing apparatus is set high in order to reduce the operating time. Also, the conventional container opening/closing apparatus is provided with a safety cover that covers a driving system in the rear side of the apparatus, and so the lower end portion of this safety cover has a closed structure.

There has been a problem as follows in the conventional container opening/closing apparatus. That is, since the velocity of opening the lid of the container is high, the inside of the container is under negative pressure at the time

of opening the lid of the container. As a result, foreign particles outside the container enter the container through the gap between the container and the container opening/closing apparatus, and the foreign particles adhere to the wafer.

In addition, there has been another problem as follows in the conventional container opening/closing apparatus. That is, since a safety cover is provided to the conventional container opening/closing apparatus so as to cover the driving system in the rear side thereof and the lower end portion of the safety cover has a closed structure, foreign particles are deposited inside the safety cover, and are blown out at the time when a lid elevator unit moves downward, and then enter the container to adhere to the wafer.

An object of the present invention is to reduce the number of foreign particles adhering to a wafer by preventing the foreign particles from entering the container at the time of opening the container using the container opening/closing apparatus.

Also, another object of the present invention is to reduce the number of foreign particles adhering to a wafer by preventing the foreign particles from being deposited inside the safety cover and preventing the foreign particles from being blown out.

DISCLOSURE OF THE INVENTION

For the achievement of the above objects, the semiconductor container opening/closing apparatus and a method of opening and closing a lid of the semiconductor wafer

container according to the present invention are characterized in that a velocity-differential pressure ratio obtained by dividing the maximum velocity (m/s) at the time of opening the semiconductor container, by the differential pressure (Pa) between the inside pressure and the outside pressure of the semiconductor manufacturing apparatus, is set to be 0.006 ((m/s)/Pa) or less.

Also, the semiconductor container opening/closing apparatus according to the present invention is characterized in that an opening is provided at a lower end portion of the cover in the rear side of the semiconductor container opening/closing apparatus.

Also, the semiconductor container opening/closing apparatus according to the present invention is characterized in that an exhaust fan is provided at a lower end portion of the cover in the rear side of the semiconductor container opening/closing apparatus.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is a perspective view of a semiconductor container opening/closing apparatus according to a first embodiment of the present invention, Fig. 2 is a perspective view of a semiconductor container, Fig. 3 is a perspective view of a semiconductor manufacturing apparatus in which semiconductor container opening/closing apparatuses according to a first embodiment of the present invention are installed, Fig. 4 is a conceptual graph showing the correlation between the maximum velocity of opening the semiconductor container and the number

of foreign particles adhering to a wafer, Fig. 5 is a conceptual view showing, relative to change of time, the velocity of opening the container by the semiconductor container opening/closing apparatus according to a first embodiment of the present invention, Fig. 6 is a conceptual graph showing, relative to change of time, the velocity of opening the container by the conventional semiconductor container opening/closing apparatus, Fig. 7 is a conceptual graph showing the correlation between the maximum velocity of opening the semiconductor container and the number of foreign particles adhering to a wafer, and Fig. 8 is a conceptual graph showing the correlation between the maximum velocity of opening the semiconductor container and the number of foreign particles adhering to the wafer.

DESCRIPTION OF THE PREFFERRED EMBODIMENTS

For more detailed description of a first embodiment of the present invention, the first embodiment will be described based on the accompanying drawings (Figs. 1 to 8).

Fig. 1 is a perspective view of a semiconductor container opening/closing apparatus (hereinafter, referred to as an opening/closing apparatus) according to the first embodiment of the present invention, Fig. 2 is a perspective view of a semiconductor container (hereinafter, referred to as a container), Fig. 3 is a perspective view of a semiconductor manufacturing apparatus (hereinafter, referred to as a manufacturing apparatus) in which the opening/closing apparatuses are installed, Figs. 4, 7, and 8 are conceptual

graphs each showing the correlation between the maximum velocity of opening the container and the number of foreign particles adhering to a wafer, Fig. 5 is a conceptual graph showing, relative to change of time, the velocity of opening the container by the opening/closing apparatus according to the first embodiment of the present invention, and Fig. 6 is a conceptual graph showing, relative to change of time, the velocity of opening the container by the conventional opening/closing apparatus.

Descriptions will be made of respective structures of an opening/closing apparatus 100 and a container 200 by using Figs. 1 and 2. The opening/closing apparatus 100 is mainly constituted by a stage 110 for placing the container 200, and an opener 120 for holding a lid 220 of the container 200 and for opening and closing the lid 220. The stage 110 is provided with positioning pins 112 for placing the container 200 in a proper condition, and a slider 111 for bringing an opener 120 closer to the container 200. In this embodiment, the slider 111 is movable back and forth by a motor and a ball screw (not shown) provided in the stage 110. Rotating keys 121 are provided on the opener 120, and the rotating keys 121 can rotate up to 90 degrees by a motor (not shown) provided in the opener 120. In the rear side of the opener 120, an opener opening/closing mechanism 130 for opening and closing the lid 220 of the container 200 by making the opener 120 move back and forth horizontally, and an opener elevator mechanism 131 for moving the opener 120 up and down are provided. Both of the opener opening/closing mechanism 130 and the opener elevator

mechanism 131 are operated by a motor and a ball screw (not shown), and a safety cover 140 is provided on the whole of both driving units of the opener opening/closing mechanism 130 and the opener elevator mechanism 131 so that a operator(s) does not touch them easily.

The container 200 is constituted by a container body 210 and the lid 220. The container body 210 is provided with four latch grooves 211, and a flange 212 is provided around the container body 210. A shelf (not shown) is provided inside the container body 210 for storing wafers 300 horizontally, and twenty-five wafers can be stored therein. Key grooves 221 are provided on the lid 220 at positions corresponding to those of the rotating keys 121 of the opening/closing apparatus 100. The rotating keys 121 of the opening/closing apparatus 100 are inserted into the key grooves 221 and rotated by 90 degrees, and thereby four latches 222 in the lid 220 come in and out from the lid 220 by a cum mechanism (not shown) operating inside the lid 220. The latches 222 are at positions corresponding to those of the latch grooves 211 of the container body 210, and when the latches 222 come out from the periphery of the lid 220 while the lid 220 is inserted in the container body 210, the lid 220 can be fixed to the container body 210.

The actual operation of opening the container 200 is carried out as follows. The container 200 is placed on the stage 110. The slider 111 on the stage 110 is moved horizontally toward the manufacturing apparatus, and a surface of the lid 220 of the container 200 and the opener 120 of the

opening/closing apparatus 100 are contacted to each other. At this time, though the flange 212 of the container 200 and a surface board 150 of the opening/closing apparatus 100 are partly contacted to each other, a gap is inevitably left therebetween due to the process accuracy of the container 200. When the rotating keys 121 are rotated by 90 degrees in the clockwise direction toward the container 200 while the lid 220 and the opener 120 are contacted to each other, the key grooves 221 of the lid 220 are rotated and the lid 220 is fixed to the opener 120 and simultaneously the latches 222 is accommodated inside the lid 220 by a function of the cum mechanism (not shown) inside the lid 220. Thereafter, the opener opening/closing mechanism 130 is horizontally moved toward the manufacturing apparatus to detach the lid 220 of the container 200 from the container body 210. Specifically, the lid 220 of the semiconductor container 200 is held and opened in a direction vertical to an opening surface of the container 200. Then, the opener 120 is moved downward by the opener elevator mechanism 131.

The operation of closing the container 200 is carried out in a reverse manner to the operation of opening the same, in which after the opener elevator mechanism 131 is moved upward, the opener opening/closing mechanism 130 is moved horizontally toward the stage 110 to connect, to the container body 210, the lid 220 fixed to the opener 120. Thereafter, when the rotating keys 121 are rotated by 90 degrees in the counterclockwise direction, the latches 222 of the lid 220 are fit into the latch grooves 211 on the container body 210 and thus the lid

220 is fixed to the container body 210. Finally, the slider 111 is moved horizontally in a direction opposite to the manufacturing apparatus, and thereby the container 200 is put into a state where it can be detached from the stage 110.

Fig. 3 shows an example where four opening/closing apparatuses 100 are mounted to a manufacturing apparatus 400. Downflow is formed inside the manufacturing apparatus 400, and the inside of the apparatus 400 is kept in the ISO cleanliness level 1 to 2, that is, the inside thereof is kept in a very clean condition in comparison to the outside of the manufacturing apparatus 400 which is in the ISO cleanliness level 6. If a wafer is left in the environment of the ISO cleanliness level 6, then foreign particles adhere to a wafer surface with time, and thereby the yield of the semiconductor components formed on the wafer is significantly decreased. The inside of the container 200 is shielded from the outside thereof, and if the wafer 300 is loaded and unloaded in the high-cleanliness environment, the cleanliness inside the container is maintained. Therefore, even if the container 200 is left in the environment of the ISO cleanliness level 6, only a small number of foreign particles adhere to the wafer 300 inside the container 200 unless the lid 220 of the container 200 is opened or closed.

When the wafer 300 is moved from the container 200 to the manufacturing apparatus 400 or from the manufacturing apparatus 400 to the container 200, the lid 220 of the container 200 is opened or closed after connection of the manufacturing apparatus 400 and the container 200 via the container

opening/closing apparatus 100, and thereby a clean area inside the manufacturing apparatus 400 and a clean area inside the container 200 are directly connected to each other. Since the pressure inside the manufacturing apparatus 400 is set to a positive pressure slightly in comparison to the outside thereof, there is little possibility that the foreign particles flow therein through the gap between the flange 211 of the container 200 and the surface board 150 of the opening/closing apparatus 100 except the moment of opening or closing the container 200.

If the operating velocity of the opener opening/closing mechanism 130 of the opening/closing apparatus 100 is high, then the inside of the container 200 becomes negative pressure at the time of pulling out the lid 220 from the container body 210, and the foreign particles enter into the container 200 through the gap between the flange 211 of the container 200 and the surface board 150 of the opening/closing apparatus 100, and adhere to the wafer 300.

Fig. 5 shows, relative to the change with time, the velocity of opening the container 200 by the opener opening/closing mechanism 130 of the opening/closing apparatus 100 according to the present invention. In Fig. 5, the horizontal axis represents time (s) and the vertical axis represents the velocity of opening (m/s), and the maximum velocity is 0.025 (m/s). Fig. 6 shows, relative to the change with time, the velocity of opening the container 200 by the opener opening/closing mechanism 130 of the conventional opening/closing apparatus 100. In Fig. 6, the horizontal axis represents time (s) and the vertical axis represents the

velocity of opening (m/s), and the maximum velocity is 0.15 (m/s).

Fig. 4 is a conceptual graph showing the correlation between the maximum velocity of opening the container and the number of foreign particles adhering to a wafer stored in the container when the inside pressure of the apparatus 400 is higher by 1 (Pa) than the pressure of the outside. In Fig. 4, the horizontal axis represents the maximum velocity (m/s) of opening the container by the opener opening/closing mechanism 130, and the vertical axis represents the number of foreign particles (Number/Wafer·Times) which have a grain size of 0.12 μm or more and which adhere to the uppermost wafer 300 stored in the container 200 per opening/closing of the container 200. Fig. 7 is a conceptual graph showing the correlation between the maximum velocity of opening and closing the container and the number of foreign particles adhering to a wafer when the inside pressure of the apparatus 400 is higher by 5 (Pa) than the pressure of the outside. The vertical and horizontal axes of Fig. 7 represent the same things as those of Fig. 4. Fig. 8 shows a conceptual graph showing the correlation between the maximum velocity of opening and closing the container and the number of foreign particles adhered to a wafer when the inside pressure of the apparatus 400 is higher by 10 (Pa) than the pressure of the outside. The vertical and horizontal axes of Fig. 8 represent the same things as those of Figs. 4 and 7.

In Fig. 4, the number of foreign particles adhering to the wafer 300 exceeds 0.01 (Number/Wafer·Times) at the maximum velocity of 0.06 (m/s), and it rapidly increases at the maximum

velocity over the 0.06 (m/s). In Fig. 7, the number of foreign particles exceeds 0.01 (Number/Wafer·Times) at the maximum velocity of 0.3 (m/s), and in Fig. 8, the number of foreign particles exceeds 0.01 (Number/Wafer·Times) at the maximum velocity of 0.6 (m/s). As is apparent from Figs. 4, 7, and 8, it can be understood that the maximum velocity, at which the number of foreign particles increases, becomes higher in proportion to the differential pressure between the inside pressure and the outside pressure of the apparatus 400.

The number of foreign particles adhering to the wafer 300 can be reduced by decreasing the maximum velocity of opening of the container by the opener opening/closing mechanism 130. However, the slow operating velocity in each unit of the opening/closing apparatus 100 influences the process faculty of the manufacturing apparatus 400 per unit time. Therefore, it is required to set the operating velocity in an appropriate range. For this reason, it is conceived that the operating velocity should be set in a certain range capable of sufficiently assuring the operation ability of the semiconductor manufacture, and also be set lower than the operating velocity at which the number of foreign particles is 0.01 (Number/Wafer·Times), which is a boundary at which the number of foreign particles adhering to the wafer begins to rapidly increase in all of Figs. 4, 7, and 8. Since the differential pressure between the inside pressure and the outside pressures of the apparatus 400 is proportional to the maximum velocity at which the number of foreign particles begins to increase, the number of foreign particles adhering to the wafer surface can be suppressed by

setting a ratio (velocity-differential pressure ratio Dvp) between the Vmax: maximum velocity (m/s) of opening the container by the opener opening/closing mechanism 130 and ΔPa: differential pressure (Pa) between the inside pressure of the apparatus 400 and the outside pressure so as to satisfy the formula 1 shown below.

$$Vmax/\Delta Pa = Dvp \leqq 0.06,$$

where ΔPa: differential pressure (Pa) between the inside pressure of the apparatus 400 and the outside pressure, Vmax: maximum velocity (m/s) of opening the container by the opener opening/closing mechanism 130, and Dvp: velocity-differential pressure ratio (m/s·Pa).

In this embodiment, since the velocity-differential pressure ratio is within the range defined by the formula 1, the number of foreign particles adhering to the wafer 300 stored in the container 200 can be reduced. Therefore, the yield of the semiconductor component can be improved.

Note that this embodiment is an example where the condition outside the container is in the ISO cleanliness level 6, and the number of foreign particles adhering to the wafer changes depending on change in the surrounding condition. However, the maximum velocity at which the number of foreign particles adhering to the wafer begins to rapidly increase is always constant.

By providing a packing at a contact position between a surface plate 150 of the opening/closing apparatus 100 and a flange 212 of the container 200 and by filling the gap between the surface plate 150 and the flange 212, the foreign particles

which enter into the container at the time of opening the lid 220 of the container 200 are shut out and therefore the number of foreign particles adhering to the wafer 300 can be reduced. If the packing is provided, however, the problems as follows are caused. That is, one is that the packing itself generates dust due to the deterioration caused by the change with time and to repetitive use of the packing, and thereby there is increase in the number of foreign particles adhering to the wafer. Another one is that the cost is increased due to the additional cost required to provide the packing itself, to process the surface plate, and to install the packing. Since the packing is not required in this embodiment, the reliability is high and the cost is low.

Also, in another embodiment (second embodiment) of the present invention, an opening is provided at a lower end portion of the safety cover 140 of the opening/closing apparatus 100. In the conventional safety cover 140, the opening is provided at only the upper end portion of the safety cover. Therefore, there has arisen such a problem that the foreign particles generated from the opener opening/closing mechanism 130, the opener elevator mechanism 131, or the like are deposited inside the safety cover 140, and that the deposited foreign particles are blown out at the time when the opener elevator mechanism 131 moves downward, and enter the container 200 and adhere to the wafer. In this embodiment, since the opening is provided at the lower end portion of the safety cover 140, the foreign particles are not deposited inside the safety cover and are not blown out. Therefore, the

number of foreign particles adhering to the wafer 300 stored in the container 200 can be reduced, and thus the yield of the semiconductor component can be improved.

The safety cover 140 covers the driving systems of the opener opening/closing mechanism 130 and the opener elevator mechanism 131 in order to ensure safety of an operator and to protect the driving systems at the time of conveying the opening/closing apparatus 100. Therefore, even if the opening is provided at the lower end portion of the safety cover 140, the safety cover does not lose its essential function.

Also, in this embodiment, the opening is simply provided at the lower end portion of the safety cover 140. However, the same effect can be expected by providing an exhaust fan at the lower end portion of the safety cover 140.

INDUSTRIAL APPLICABILITY

As described above, according to the present invention, it is possible to reduce the number of foreign particles entering into the container at the time of opening the container, and therefore the number of foreign particles adhering to the wafer can be reduced and the yield of the semiconductor component can be improved. In addition, since the packing is not required, the opening/closing apparatus having high reliability can be realized at low cost.

Also, according to the present invention, since the foreign particles are not deposited inside the safety cover, the foreign particles are not blown out, and thus the number of foreign particles adhering to the wafer can be reduced.

Therefore, the yield of the semiconductor component can be improved.

What is claimed is:

1. A semiconductor container opening/closing apparatus, comprising:

a stage for placing a semiconductor container accommodating a semiconductor wafer;

a connection portion for connecting an opening of said semiconductor container and an opening of a semiconductor manufacturing apparatus;

an opener for holding a lid of said semiconductor container and then opening and closing said lid in a direction vertical to an opening surface of the container; and

an opener elevator mechanism for moving down the opener holding the lid of said semiconductor container so as to connect the opening of said semiconductor container and the opening of said semiconductor manufacturing apparatus while both of the openings are opened, or for moving up said opener so as to close the connection between said openings,

wherein an operating velocity of opening the container by the opener is set such that a velocity-differential pressure ratio obtained by dividing the maximum velocity at the time of opening the lid of said semiconductor container, by the differential pressure between the inside pressure and the outside pressure of said semiconductor manufacturing apparatus, becomes 0.06 ((m/s) Pa) or less.

2. A semiconductor container opening/closing apparatus, comprising:

a stage for placing a semiconductor container accommodating a semiconductor wafer;

a connection portion for connecting an opening of said semiconductor container and an opening of a semiconductor manufacturing apparatus;

an opener for holding a lid of said semiconductor container and then opening and closing said lid in the direction vertical to an opening surface of the container;

an opener elevator mechanism for moving down the opener holding the lid of said semiconductor container so as to connect the opening of said semiconductor container and the opening of said semiconductor manufacturing apparatus while both of the openings are opened, or for moving up said opener so as to close the connection between said openings; and

a cover for covering both said opener having moved down and said opener elevator mechanism,

wherein an opening is provided at a lower end portion of said cover in the rear side of said semiconductor container opening/closing apparatus.

3. The semiconductor container opening/closing apparatus according to claim 2,

wherein an exhaust fan is provided at a lower end portion of said cover in the rear side of said semiconductor container opening/closing apparatus.

4. A semiconductor device manufacturing method, comprising the steps of:

accommodating a semiconductor wafer in a semiconductor container and conveying between each semiconductor manufacturing apparatus;

connecting an opening of said semiconductor container and

an opening of said semiconductor manufacturing apparatus;

connecting said openings such that a velocity-differential pressure ratio obtained by dividing the maximum velocity at the time of vertically opening a held lid of said semiconductor container, by the differential pressure between the inside pressure and the outside pressure of said semiconductor manufacturing apparatus, is set to be 0.06 ((m/s) Pa) or less; and

processing a semiconductor wafer accommodated in said semiconductor container.

Fig. 1

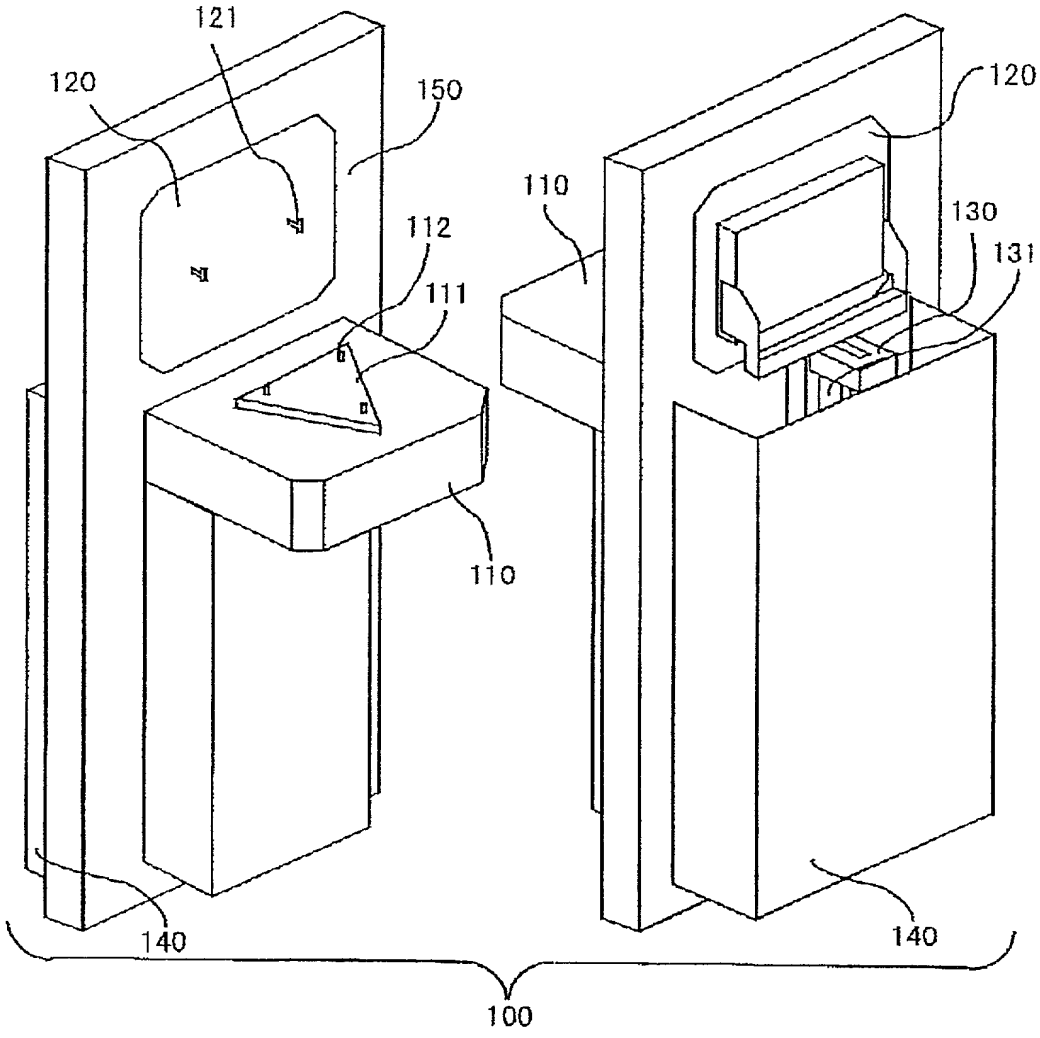


Fig. 2

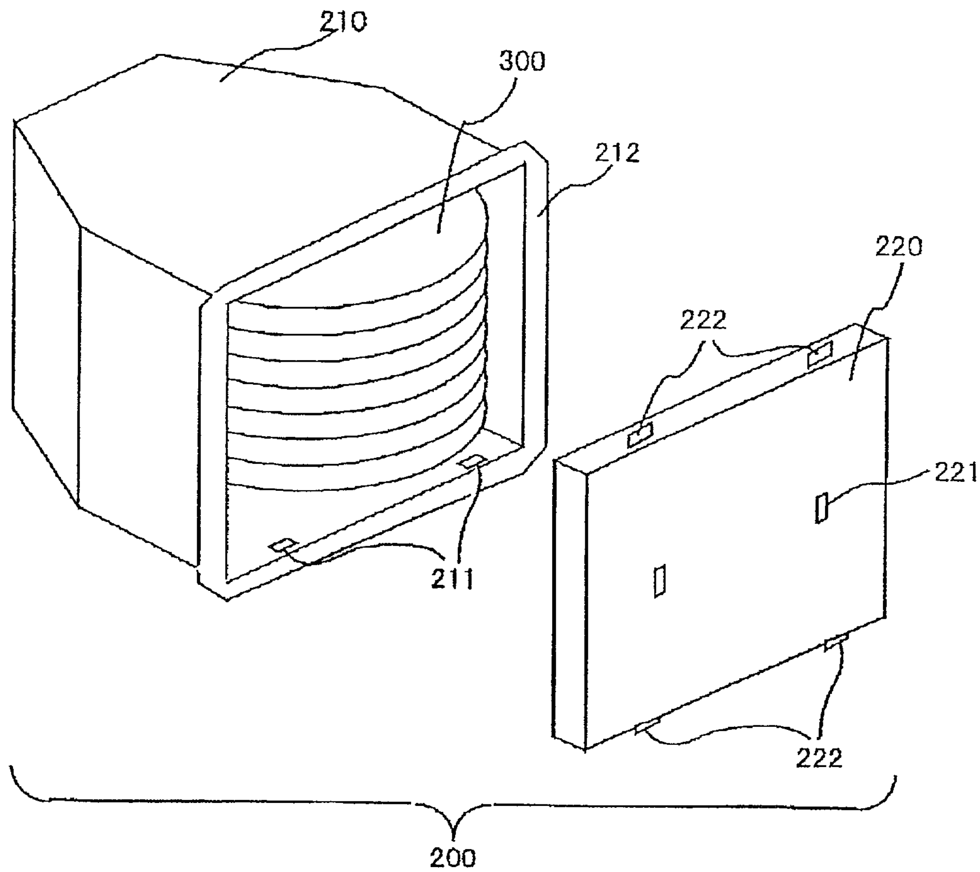


Fig. 3

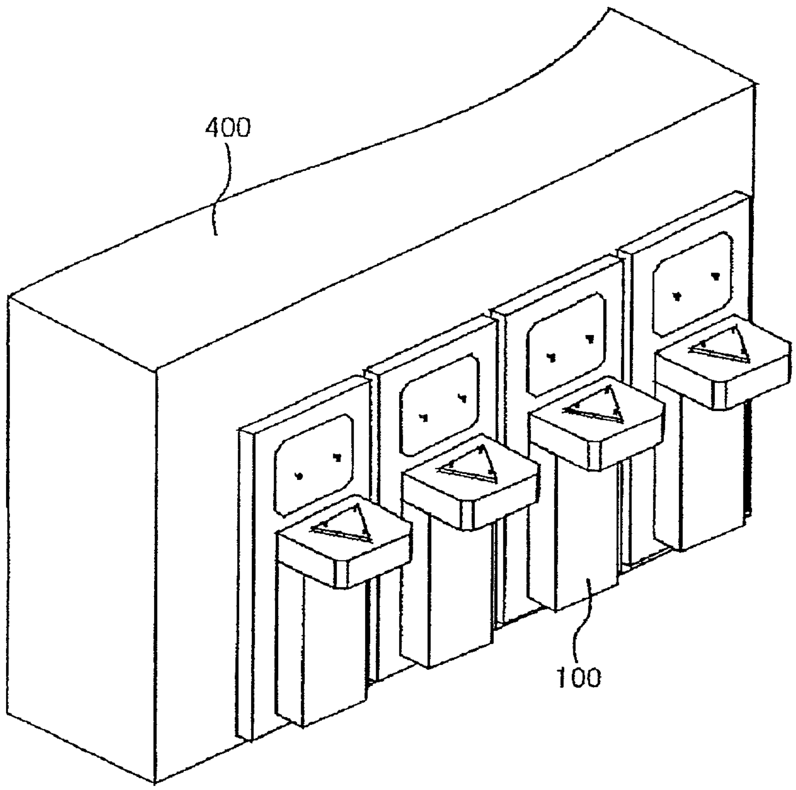


Fig. 4

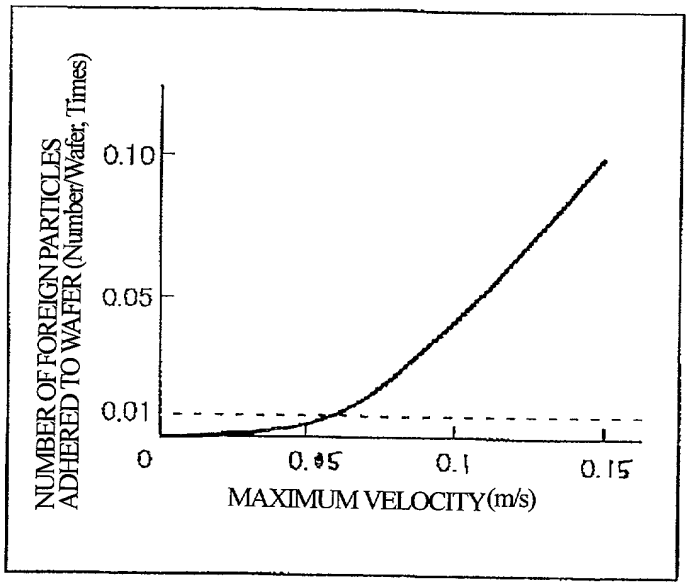


Fig. 5

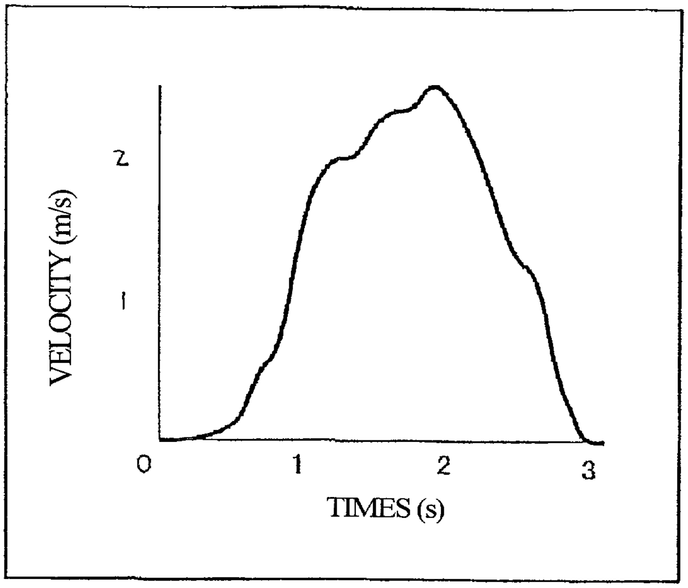


Fig. 6

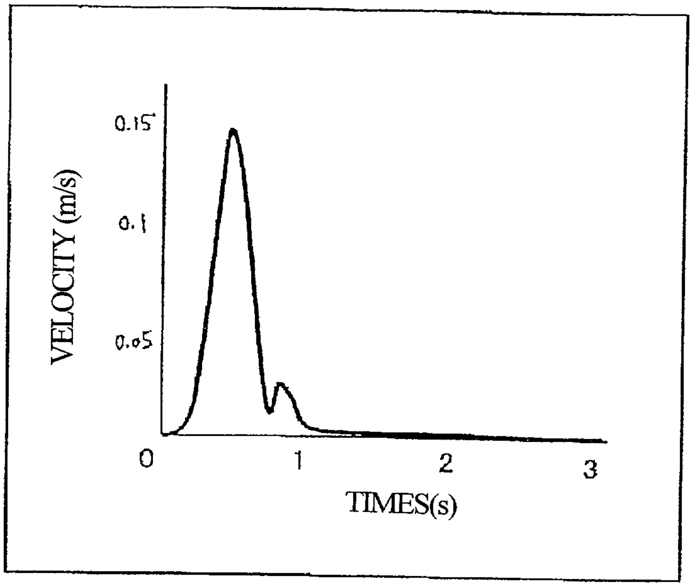


Fig. 7

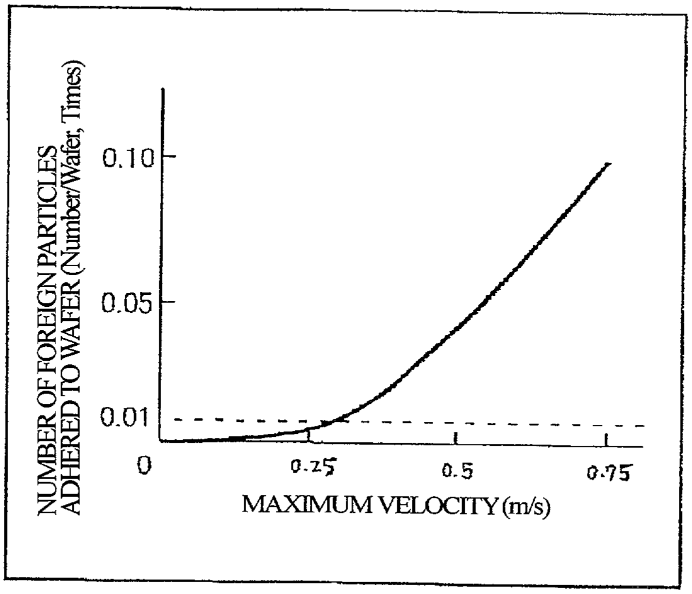
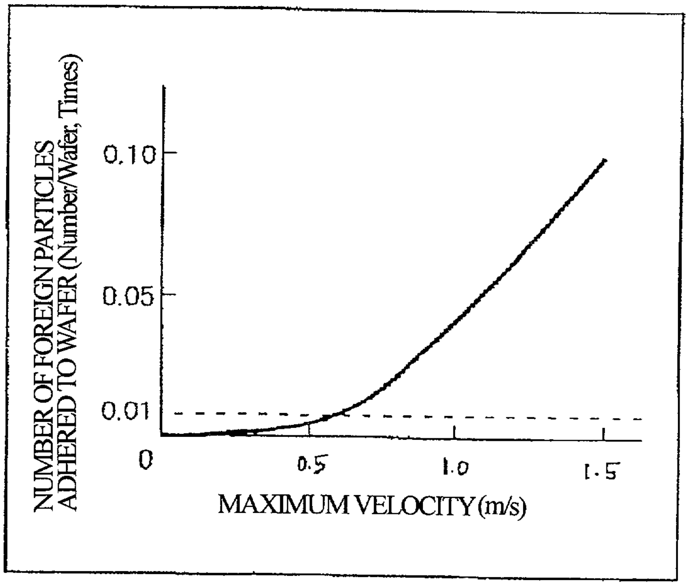

NUMBER OF FOREIGN PARTICLES
ADHERED TO WAFER (Number/Wafer, Times)
0.10
0.05
0.01
0
0.25
0.5
0.75
MAXIMUM VELOCITY (m/s)

Fig. 8



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特許出願宣言書及び委任状

Japanese Language Declaration

日本語宣言書

下記の氏名の発明者として、私は以下の通り宣言します。

As a below named inventor, I hereby declare that:

私の住所、私書箱、国籍は下記の私の氏名の後に記載された通りです。

My residence, post office address and citizenship are as stated next to my name.

下記の名称の発明に関して請求範囲に記載され、特許出願している発明内容について、私が最初かつ唯一の発明者（下記の氏名が一つの場合）もしくは最初かつ共同発明者であると（下記の名称が複数の場合）信じています。

I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

SEMICONDUCTOR CONTAINER OPENING/CLOSING APPARATUS AND SEMICONDUCTOR DEVICE MANUFACTURING METHOD

上記発明の明細書（下記の欄で×印がついていない場合は、本書に添付）は、

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☐ __月__日に提出され、米国出願番号または特許協定条約国際出願番号を_____とし、
(該当する場合) _____に訂正されました。

☒ was filed on July 27, 2000
as United States Application Number or
PCT International Application Number
PCT/JP00/05012 and was amended on
_____ (if applicable).

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I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56.

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I hereby claim foreign priority under Title 35, United States Code, Section 119 (a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT international application which designated at least one country other than the United States, listed below and have also identified below, by checking the box, any foreign application for patent or inventor's certificate, or PCT International application having a filing date before that of the application on which priority is claimed.

Prior Foreign Application(s)
外国での先行出願

(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願年月日)	Priority Not Claimed 優先権主張なし
11-211724	Japan	27/July/1999	☐
			☐

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(Application No.) (出願番号)	(Filing Date) (出願日)

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I hereby claim the benefit under Title 35, United States Code, Section 120 of any United States application(s), or 365(c) of any PCT international application designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT International application in the manner provided by the first paragraph of Title 35, United States Code Section 112, I acknowledge the duty to disclose information which is material to patentability as defined in Title 37, Code of Federal Regulations, Section 1.56 which became available between the filing date of the prior application and the national or PCT international filing date of application.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Status: Patented, Pending, Abandoned) (現況：特許許可済、係属中、放棄済)

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true, and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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委任状： 私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。（弁護士、または代理人の氏名及び登録番号を明記のこと）

POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number)

(10)

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私書箱	Post Office Address c/o Hitachi, Ltd., Intellectual Property Group New Marunouchi Bldg. 5-1, Marunouchi 1-chome, Chiyoda-ku, Tokyo 100-8220, Japan

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住所		Residence Hiratsuka, Japan JPX
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第三共同発明者の署名	日付	Third inventor's signature Date Kenji Tokunaga 20/Nov./2001
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第五共同発明者の署名	日付	Fifth inventor's signature Date
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(第六以降の共同発明者についても同様に記載し、署名をすること)

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日本語宣言書

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As a below named inventor, I hereby declare that:

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I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled

SEMICONDUCTOR CONTAINER OPENING/CLOSING APPARATUS AND SEMICONDUCTOR DEVICE MANUFACTURING METHOD

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(該当する場合) _____に訂正されました。

☒ was filed on July 27, 2000
as United States Application Number or
PCT International Application Number
PCT/JP00/05012 and was amended on
_____ (if applicable).

私は、特許請求範囲を含む上記訂正後の明細書を検討し、内容を理解していることをここに表明します。

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

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Prior Foreign Application(s)
外国での先行出願

(Number) (番号)	(Country) (国名)	(Day/Month/Year Filed) (出願年月日)	Priority Not Claimed 優先権主張なし
11-211724	Japan	27/July/1999	☐
			☐

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I hereby claim the benefit under Title 35, United States Code, Section 119(e) of any United States provisional application(s) listed below.

(Application No.) (出願番号)	(Filing Date) (出願日)	(Application No.) (出願番号)	(Filing Date) (出願日)

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委任状： 私は下記の発明者として、本出願に関する一切の手続きを米特許商標局に対して遂行する弁理士または代理人として、下記の者を指名いたします。（弁護士、または代理人の氏名及び登録番号を明記のこと）
POWER OF ATTORNEY: As a named inventor, I hereby appoint the following attorney(s) and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith (list name and registration number)

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Filing Date	January 25, 2002
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